

REMARKS

By the present amendment, claims 1, 2, 3 and 5 are pending in the application. Claims 1 and 2 are independent claims.

Claim Amendments

The amendments to claims 1 and 2 directed to the “pins” are supported in the specification, e.g., at page 7, lines 4 to 6.

§103

Claims 1 to 5 were rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,338,765 to Statnikov (the “‘765 patent”).

This rejection, as applied to the amended claims, is respectfully traversed.

Patentability

The depth of the structure improved layer.

As pointed out by the Office Action, the ‘765 patent clearly mentions that microstructure can be improved by means of UIT (ultrasonic impact technology, Col. 5, lines 24-25), such as, column 5, lines 54-55 “to improve the grain structure” and column 6, lines 62-64 “modified material structure”. However, the ‘765 patent only describes that “white layers are formed typically one micron thick” (col. 7, lines 5 to 7). There is no description about a more concrete depth.

In addition, the ‘765 patent does not disclose or suggest the characteristic feature of the present invention as to average of longitudinal axis of crystal grains at a depth of at least 2 mm from the surface of the steel plate in the microstructure adjacent to a fusion line of a weld metal to equalize the grain diameter of the HAZ to a base steel plate.

Considering a description of white layers, a structure is only improved at most at the surface layers in the ‘765 patent. A person skilled in the art could not easily conceive the characteristic feature of the present invention of the average of longitudinal

axis of crystal grains at a depth of at least 2 mm from the surface of the steel plate in the microstructure adjacent to a fusion line of a weld metal to equalize the grain diameter of the HAZ to a base steel plate, and the crystal grain size of the steel plate matrix before the welding at a depth of $\frac{1}{4}$ of the thickness from the surface of the steel plate, based on the teachings of the '765 patent.

We cannot analyze a detail UIT process described in the '765 patent. However, the attached technical publication "IIW/IIS Doc.XIII-1757-1999" Guideline For Application Of Ultrasonic Impact Treatment Improving Fatigue Life Of Welded Structure" written by S. Statnikov (same as the inventor of the '765 patent) describes a detail UIT process on page 7. Comparison with this UIT process, although the indenter diameter of this UIT process is 2-5 mm, the indenter diameter of the present invention is 5-30 mm. It is clearly seen that the indenter diameter of the present invention is quite different from that of the UIT process of this publication which relates to the '765 patent. This difference causes an increased thicker structure and improved layer from the surface of the steel plate in the present invention as compared to the '765 patent.

Means of toughness improvement.

The Office Action asserted that it is easily conceived that toughness is improved by a removal of voids and repair of cracked structure, column 10, lines 20-40. It is well known that toughness is improved by a reduction of voids cracks. However, the present invention does not rely on this teaching.

The present invention solves a problem of toughness improvement by means of subjecting a surface of a heat affected zone formed by a last pass of a multi-layer welded joint of a steel plate to impacts by an ultrasonic vibration tool using one or more pins having a diameter of 5 to 30 mm with an oscillating amplitude of between 20 to 60 μm to

thereby make an average of longitudinal axis of crystal grains at a depth of at least 2 mm from the surface of the steel plate in the microstructure adjacent to a fusion line (FL) of a weld metal and a steel plate matrix in said heat affected zone formed by the last pass equivalent to the crystal grain size of the steel plate matrix before the welding at a depth of $\frac{1}{4}$ of the thickness from the surface of the steel plate. This inventive idea cannot be conceived by a person skilled in the art based on the '765 patent and such a technical publication.

Further, it is submitted that it is difficult to conceive that toughness improvement can be seen by a bulk impact test using 10 mm x 10 mm test piece for a Charpy impact test based on the teaching of a white layer in the '765 patent. In addition, it is well known that steel becomes brittle and lowers toughness when plastic strain is applied. Although the UIT process is useful to apply large plastic strain to the steel, it cannot be easily applied to a steel plate for improving toughness.

Fatigue strength and toughness.

It is well known that there is no relationship between toughness and fatigue strength. According to the attached standard "Fatigue Design Of Welded Joints And Components" XIII-1539-96/XV-845-96, The International Institute of Welding, fatigue strength and fatigue life only depend on the applied force and the shape of weld joint, and does not depend on toughness level of the steel plate or weld joint. In other words, it is understood that when the shape of weld joint (if the shape of weld joint is the same, stress concentration coefficient and weld retained stress are the same), the same level of fatigue strength and same fatigue life are achieved.

It is therefore submitted that amended independent claims 1 and 2, and claims 3 and 4 dependent thereon, are patentable over U.S. Patent No. 6,338,765 to Statnikov.

CONCLUSION

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application, as amended, be allowed and passed for issue.

Respectfully submitted,

KENYON & KENYON LLP

By:


John J. Kelly, Jr.
Reg. No. 29,182

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KENYON & KENYON LLP
One Broadway
New York, NY 10004
Telephone No. (212) 425-7200
Facsimile No. (212) 425-5288
CUSTOMER NO. 26646